



## Geologic Environments and Human Health in China

Natural geologic environments in China affect human health in a variety of ways through interactions between geochemical, hydrologic, and biologic processes and human activities. Numerous national-scale cases serve as examples, including correlations between the distribution of Keshan and Kaschin-Beck diseases (both thought to be associated with nutritional deficiencies) and the northeast-southwest-oriented low selenium belt in temperate forests and forest-grass regions (Fang 2002). The areas of fluorine-related endemic ailments, which occur in one-half of China's 2,171 counties, have a distribution that tends to match that of regions with high-fluorine rocks, aquifers, springs, and coals (Cai 1995).

Environmental factors such as climate, along with the human activities and cultural customs, can also enhance health impacts in areas with high natural background concentrations of hazardous geochemical compounds. The serious arsenicism in parts of Guizhou Province is related not only to the high arsenic content (as high as 35,000 ppm) in local Permian coal deposits but also to the cold and humid winter conditions on the high plateau in the western part of the province. Residents there heat their homes by burning locally obtained coal in open fires. Because most houses do not have chimneys, the arsenic-containing smoke goes directly into the living areas. Moreover, residents often hang corn and chili peppers over the fires in their homes to dry them for later use. This practice can transfer the arsenic from the coal coating and permeating the peppers and corn by sublimation, and then of course entering the body when the food is eaten (Zheng 1996). Naturally occurring radioactive radon gas is also a health problem in some regions of China. In these areas the radon, which has been linked to lung cancer, can enter homes either through direct emission from rocks or soils, or through bricks that have been made from radon-rich mining waste.

Some health problems are related to special landscape settings. Tens of millions of people in China rely on karst aquifers for drinking water. These aquifers are formed by dissolution of soluble limestone bedrock, which forms caves, sinkholes, and other related features; the groundwater resources that these aquifers contain are vulnerable to contamination. Such problems are widespread: in southwest China, limestone covers an area of more than 500,000 km<sup>2</sup>. Because of karst development in these areas, water resources in the region are based on nearly 3,000 underground streams, with a total length of some 14,000 km and total discharge of more than 100 billion L/day. In these areas, major land resources distributed above the underground streams use these streams as drainage systems. The types of land use in the area have the potential to create contamination problems; for example, urbanization, mining, farming, manufacturing, or highway construction can all bring about degradation of groundwater quality and associated human health problems. In Shanxi Province, which is the major energy base of China because of its rich coal resources, extensive coal deposits overlie large carbonate rock karst aquifers, the most important source of local water supplies. The pollution of large karst springs by sulfur, lead, cyanide, and other contaminants from coal and related chemical industries results in serious health concerns. Iodine deficiency symptoms also occur often in limestone regions.

In total, high fluorine, low iodine, low selenium, and low molybdenum symptoms affect about 300 million people in China (Fang 2002). In an effort to address such diseases with biochemical origins, a special leading committee under the State Council, with the involvement of seven ministry-level institutions, was established in 2000. Special programs addressing particular problems, such as the



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Program to Dispel Iodine Deficiency Symptoms in China, have been implemented. To aid in the planning of governmental actions, an *Atlas of the Ecological Environmental Geochemistry of China* has been published (Li and Wu 1999). The 209-page atlas contains 107 maps, including the following national

maps: 24 geochemical maps showing elemental distributions (Al, As, B, Ca, Cd, Co, Cr, Cu, F, Fe, Hg, K, Li, Mg, Mn, Mo, Na, Ni, P, Pb, Sr, Ti, V, and Zn); 8 maps showing available elements in soil (B, Cu, Fe, Mn, Mo, Zn, K, and P); 9 dietary intake maps (Ca, Cu, Fe, K, Mn, Na, P, Se, and Zn); 14 maps showing elements measured in human hair (Al, As, Ca, Co, Fe, Hg, K, Mo, Ni, Se, Sr, Ti, V, and Zn); and 6 maps showing mortality of liver, stomach, and esophageal cancers for both men and women (Li and Wu 1999).

Many practical steps have been taken to prevent and cure the most serious of these environmentally caused health problems. In certain regions of Huhhot City, Baotou City, and Bayannur Meng Prefecture, Inner Mongolia Autonomous Region, the arsenic content in groundwater is much higher than the national standard. As of 2000, this had affected about 300,000 people. A new project has been launched—the Changing Source of Water Supply to Prevent Arsenicism—at a cost of 15 million yuan (RMB). During the project's first phase in 2001, about 68,600 people from 207 villages were able to obtain safe drinking water. Another 63,000 people will have safe drinking water when the second stage is finished later in 2002 (Li 2002). International cooperation in biogeochemical research, prevention and cure of geochemically related disease, better land use planning and management, and increased environmental protection are already improving the living conditions and health of the people in these areas.

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## Beijing Tackles Its Environmental Problems with a New Field Experiment

As an extremely large metropolitan area and the host city of the 2008 summer Olympics, Beijing, China, faces a great challenge to improve its air quality as it strives to showcase a “green Olympics” in a few years. What can be done to alleviate the impact of dust storms and reduce air pollution? The Beijing City Air Pollution Observation Field Experiment (BECAPEX) is one step toward improving air quality in the capital city.

The experiment, which was sponsored by the Ministry of Science and Technology of China, is a subprogram of the Beijing Urban Environment Project. The focus of the field experiment carried out in the Beijing metropolitan area in spring 2001 was on the dynamics of air pollution, a key theoretical problem with applications in the formation mechanism, control, and alleviation of air pollution. A three-dimensional observing network using ground-based observations and space-based satellite remote sensing was set up to monitor the urban environment in and around Beijing. It was the first broad attempt at observation in Beijing using advanced observation instruments such as atmospheric profilers, tether sondes, ultrasonic anemometers, and sonic detection and ranging (SODAR).

The results from BECAPEX provided a detailed three-dimensional description of the dynamic and thermal structure of Beijing's urban atmospheric environment, the physical and chemical characteristics of air pollutants and their variations, and the mechanisms of transportation, diffusion, and transformation of air pollution. The data revealed the existence of an air dome (a dome-shape boundary layer) around urban Beijing and provided a comprehensive set of parameters that defined the characteristics of the air dome. The variation of these parameters determines the severity of air pollution in Beijing. Thus, warning signals related to severe pollution events can be detected by monitoring these parameters.

Important findings of this study include the synchronous characteristics of the life cycle of pollutants within the urban atmospheric boundary layer and obvious diurnal variation in the vertical transport



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of pollutants in the boundary layer or under the air dome. In fact, the data revealed that the air dome acted like a large canopy covering the city of Beijing. This phenomenon was closely associated with the temperature inversion and the vertical structure of the boundary layer. Moreover, the diffusion and distribution of air pollutants were related to the multiscale interaction among large-scale circulation, mountain and valley wind, and urban heat island circulation. As a result, air pollution in Beijing usually comes from local sources, but the sources in the vicinity also have prominent influence.

The primary goal of the experiment was to determine the effect of dust storms on Beijing's urban environment. Each spring, dust storms cause serious weather conditions in Beijing, which affects the entire population. BECAPEX studied the dust storm events that occurred in 2000 and identified the sources of these events. The data showed that most of the dust storms in Beijing during 2000 originated in a large dry area north of the city. High-speed winds caused friction on the ground that allowed the dust-laden winds to penetrate Beijing's urban air dome, resulting in thick, dust-laden air near the ground. These findings laid a solid foundation for developing strategies to improve air quality and for the city's Blue Sky, Clear Water project.

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